

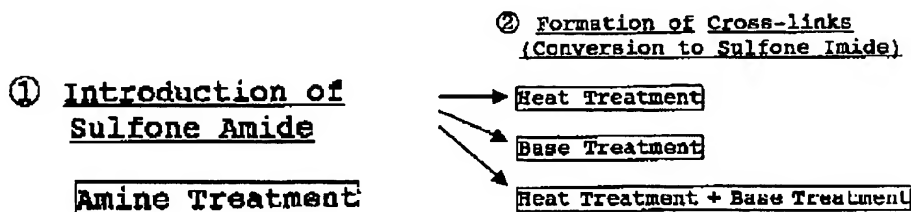
REMARKS/ARGUMENTS

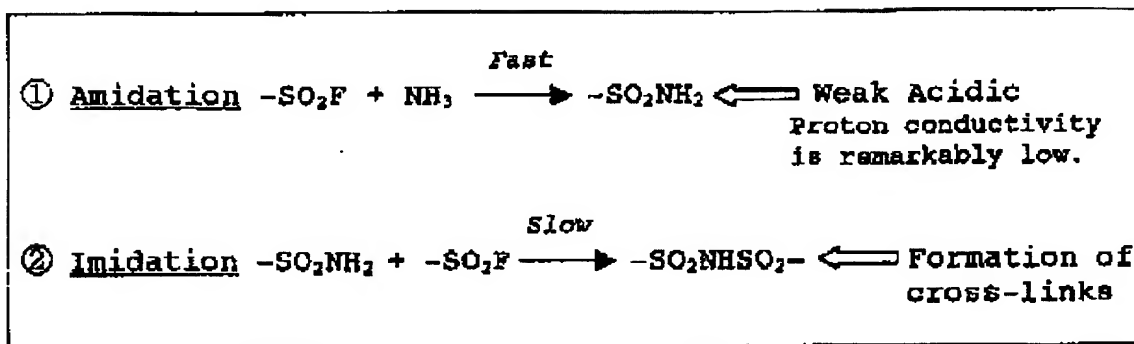
Claims 37, 39-53, and 55-66 are now active in the present application. Claims 38 and 54 have been cancelled and their limitations added into claims 37 and 53, respectively.

Additionally, claims 37, 45 and 53 have been amended to specify that the amine contacting step is performed, the amine-contacted polymer electrolyte or precursor thereof is separated from the amine compound, followed by either or both of the heat treatment and base treatment steps, to clarify that these steps are performed sequentially, not simultaneously. These amendments are supported by the specification and examples. New claims 64-66 have been added and are supported by the specification at page 14, lines 10-16. No new matter has been added by these amendments.

The present invention relates to a process for producing a modified electrolyte by first contacting a solid polymer electrolyte or precursor thereof, with an amine compound, then after completion of the amine contacting step, subjecting the resultant amine-contacted solid polymer electrolyte or precursor thereof to either or both of a heat treatment step or a base treatment step. Applicants have found that this sequential performance of amine contacting followed by either or both of heat treatment or base treatment provides significant advantages in heat resistance and creep resistance of the final modified electrolyte, while giving almost no decrease in electric conductivity.

The present invention will be further described with respect to a preferred embodiment, namely the use of a polymer electrolyte containing sulfonyl fluoride groups as the electrolytic group ( $-\text{SO}_2\text{F}$ ). The method of the present invention proceeds as follows:





Thus, in the first step, amine treatment results in amidation of the sulfonyl fluoride. In the second step, cross-links are formed (without the presence of amine, i.e. after separation of the amine-contacted solid polymer electrolyte or precursor from the amine compound) in order to minimize the remaining sulfone amide. By performing the reaction sequentially, Applicants have found that the remaining amount of sulfone amide can be reduced more effectively, resulting in avoidance of the conductivity lowering caused by such sulfone amide. However, when the process is performed simultaneously, i.e. contacting with amine and heating in the presence of the amine, or base treatment also in presence of the amine, there is an increase in the sulfone amide remaining in the final product, thus lowering the proton conductivity of the product. Thus, the present invention provides an improved final product by promoting cross-linking, but maintaining the levels of conductivity needed.

Claims 37, 40 and 42-44 stand rejected under 35 U.S.C. 103 over Helmer-Metzmann et al. Helmer-Metzmann et al disclose contacting an aromatic electrolyte polymer with an amine compound (see column 4 and Examples). The Examiner has asserted that the reference teaches a heating step as required in the present invention, because the reference permits the reaction mixture to warm from 0°C to room temperature (about 25°C, depending on ambient conditions). In order to clearly distinguish from such a step (which Applicants still do not agree is a heating step as that term would be used in the relevant art), Applicants

have now specified that the heating must be in the range of from 40-200°C. At the temperatures used by the reference (i.e. room temperature) the formation of cross-links is not sufficient. However, at the temperatures of the present invention, crosslinking is promoted to provide significantly improved properties in the final product. Clearly, the reference was not concerned with crosslinking and as such, nowhere suggest heating at the temperatures of the present invention. Additionally, the reference nowhere suggests separation of the amine-contacted polymer electrolyte from the amine compound *prior to* warming up to room temperature. The present invention requires that after the amine contacting step, the amine-contacted polymer electrolyte be separated from the amine compound prior to any heating step. Since there is no disclosure or suggestion within Helmer-Metzmann et al to perform a heating step at the temperatures required in the claims as amended, or to separate the amine-contacted polymer electrolyte from the amine compound prior to any heating step, this reference cannot render the invention obvious as claimed. Accordingly, this rejection should be withdrawn.

Claims 38-63 stand rejected under 35 U.S.C. 103 over Michot et al. Michot et al disclose contacting a perfluoro electrolyte polymer with an amine compound, such as ammonia. The only application of heat suggested or disclosed by Michot et al, particularly in the Examples section singled out by the Examiner, is heating of a reaction mixture *while contacting the polymer with the amine compound*. However, the reference neither discloses nor suggests sequential treatment with an amine compound, followed thereafter by heat or base treatment *after removal from the amine compound*. In each of the examples of the reference, the polymer membrane is put in contact with an amine compound and heated in the presence of that amine compound. As noted above, such heating (or base treatment) in the presence of the amine compound results in a buildup of amine converted electrolyte groups (such as sulfone amide groups in the case where the electrolyte group is a sulfonic acid or

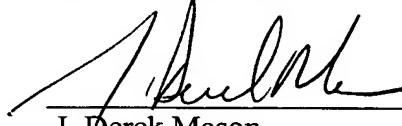
sulfonyl fluoride), which lower the proton conductivity of the final product. This is highly undesirable and is one of the major improvements provided by the present invention method. By separation of the amine-treated polymer electrolyte from the amine compound, prior to any heat or base treatment step, the present invention provides a cross-linking reaction without the buildup of groups detrimental to the conductivity of the final product. Michot et al nowhere discloses or suggests such a process where, prior to any heat or base treatment step the amine compound is separated from the amine-contacted solid polymer electrolyte. Further, the reference makes no suggestion as to how such a sequential process would provide any improvement over the simultaneous process described in the reference. As such, Applicants submit that the Michot et al reference does not render the present invention obvious and the rejection should be withdrawn.

Since none of the references disclose contacting a solid polymer electrolyte with an amine compound, and separation of the amine-contacted solid polymer electrolyte from the amine compound, followed by either a heat treatment or base treatment step (or both), the references cited cannot render the present invention obvious and therefore the rejections should be withdrawn.

Applicants submit that the application is now in condition for allowance and early notification of such action is earnestly solicited.

Respectfully submitted,

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